THE COMPARISON OF P/TR AND K/T BOUNDARIES ON THE BASIS OF COSMIC SPHERULES FOUND IN HUNGARY

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Introduction: The major mass extinctions of taxa, enhanced tectonics, sea level changes, volcanic activities were taken place during both of these great extinction levels: Permo-Triassic (P/Tr) and Cretaceous-Tertiary boundaries (K/T) [1,2]. We give here a brief summary on our analyses of cosmic spherules extracted from geologic samples found in Hungary in the P/Tr and close to the K/T boundaries. Moreover we suggest a new stratigraphic method to establish relation between spherules and the conventional geologic and various other stratigraphic layers on the Earth and on other objets in the Solar System.

P/Tr and K/T differences: The uncertainties of time scale and dating as well as the inherent limits of resolution of the time of extinctions of taxa are summarized by [3,4,5]. The range of uncertainty in the estimated age of the P/Tr boundary is about 20 Myr; the error is not symmetrical about the 248 Myr age given by [3]. There is a big difference between the P/Tr and K/T in the duration and in the uncertainty of dating. The duration of K/T episode is much sharper: the extinction took place in about five distinct steps over a probable interval of about 2.0 t 2.5 Myr, extending from the middle-upper Maestrichtian boundary into the early Paleocene; the end of the Maestrichtian has been variously estimated at 65 to 66.4 Myr ([3,6]). Because the interest has focused on the K/T mass extinctions and other events with a possible extraterrestrial cause, the record across the P/Tr boundary is too poor for detailed study. The cause of the end-Permian mass extinction appears to involve a tangled web rather than a single mechanism. Three phases can be identified during a longer interval [7]. This mass extinction is related to plenty of disciplines as paleobiology, paleoclimatology, pelaoceanography, paleotectonics, paleovolcanic activity, (continents, sea level changes, seafloor, gases, anoxia, CO_2), extinct and survived (or altered) taxa etc.. The sedimentary rock generally contains cosmic dust, volcanic ash, skeletons, fossils etc.. The microspherules in P/Tr bedded chert were estimated by PIXE analysis by [8]. They found that 1) the origin of microspherules as inferred from the Ti/Fe and Cr/Fe ratios is clearly extraterrestrial; and 2) their average chemical composition is quite similar to the magnetic components of carbonaceous chondrite; 3) most of the spherules are hollow and are smaller than those obtained from recent drill core samples; 4) the number of the microspherules shows a sharp increase in the Triassic-Jurassic boundary layer. They concluded that these possible evidences seem to support the molecular cloud hypothesis, i.e. that the Solar System encountered an interstellar molecular cloud in the past. Connecting the strange chemical composition changes of gases (anoxia) in the atmosphere and sea during the P/Tr episode some authors consider the consequences of supernova explosions on the atmosphere of the Earth. Recent models emphasize volcanism, global tectonism, enormous volcanic activities (flood basalt: [9,10]), sea-floor volcanism, global climatic changes as well as possible extraterrestrial impacts. It is concluded [11] that the microspherules found in the P/Tr boundary cannot be associated with impact events. However, recently during at the annual meeting of the Geological Society of America, paleontologist G. Retallack has presented pictures of microscopic quartz grains that he claims are the "first unequivocal evidence of an impact" [12]. It is obvious that the P/Tr boundary is a consequence of complexity of various events. However, both the P/Tr and K/T events belong to the same cosmic cycle of periodicity: so-called shorter Holmes cycle with an esitmated famous period around 30 Myr ([13,14]). There are lot of arguments that the K/T boundary is related to violent cosmic impact events (see as example lot of papers reviewing the K/T related topics mainly the impact craters, dating, anomalies of iridium and other elements and global phenomena among others by [15–22]). However, there are some difficulties associated with the iridium anomalies found in the K/T: there are arguments that this could be originated from enormous volcanic activity [23]. Further problem with the impact related extinction events in the K/T was discussed by [24] and he concluded that it looks as though a bolide impact alone cannot explain the whole of the biotic crisis at the end of the Cretaceous. However, it is seems to be that the impact hypothesis is confirmed according to the discovery of evidences of the relicts and traces of a huge impact event in the India-Seychelles rift margin ([21]), called as "Shiva Crater" after [14] with sizes of 600×450 km. Even this crater can be linked to Chicxulub genetically: both craters might have originated when two fragments from a larger meteorite crashed on a rotating Earth and due to the geometry and rotational phase these craters are in antipodal position [21]. The example of the crash of fragments of comet Shoemaker–Levy 9 on Jupiter provides the analogy the giant "drumfire" on the Earth in the K/T period.

New Results. Comparison of spherules: We have confirmed that the P/Tr boundary is related to cosmic events because the spherules have been collected in the Bükk mountain, Hungary, show evidences on interstellar origin rather than results of high velocity impacts of cosmic bodies [25]. The similarites are evident between our small spherules and those reported by [8]. We argue that the consequences of explosion of a nearby supernova could be the source of the P/Tr spherules and the other dramatic atmospheric changes and other terrestrial paleoenviromental effects [26] when the Solar System encuntered with the shock front. According to the chemical and morphological analyses of the spherules in the geological samples collected in Hungary we report evidences that the spherules have been found: 1) in the upper Cretaceous formations [27], as well as 2) the extraterrestrial magnetic spherules in the Senonian alluvial sediments of the Southern Bakony mountains [28] are rather impact than volcanic origin associating with the Cretaceous-Tertiary (K/T) events. Thus the P/Tr and K/T events show differences in the nature and origin of related cosmic spherules: in the P/Tr boundary mainly those spherules dominated which have probably interstellar origin (or the cosmic dust and the possible impactor bodies contained interstellar material which have encountered with our planet); while in the K/T the spherules were created during violent impact events. However, the occurence of some impact events cannot be excluded in the P/Tr [12], but the dominancy of impact events is less significant.

A Retrospective View: There are evidences from the analyses of lunar soil samples that impact events could be identified in the past on the Moon's surface according the analysis of glassy spherules with in size range of less than 200 microns [29]. There are characteristic differences between spherules with volcanic and impact origin. Volcanic glasses are larger in size (in average) ca.

100 micrometer range, while impact spherules are in the 0.1–10 micrometer range. Volcanic spherules represent those basaltic melts which originated in the lunar mantle. Volcanic spherules can be arranged according to their Ti content: from green (A-15) glasses, through yellow (A-15, and A-17) and orange (A-17) glasses till the red (A-15) glass. Impact spherules represent both residuals of quick volatile evaporation (HASP: High Al, Si Poor) and quickly condensated volatile rich (VRAP) types [29]. Impact spherules can be characterized by volatile losses in different degree. Extreme volatile losses left the most refractory constituent of the mineral originally had been present in the rocks of soil. The radiometric ages were measured only for 74220 type volcanic glass spherules among Apollo 17 samples, however, their ages is rather old (3.48 – 3.66 Myr, obtained earlier by several authors [30]). On impact glasses no age determination have been carried out [29].

New Perspective: The study of spherules is a new tool which allows to dating the impact chronology in the Earth's environment studying the samples in order to compare them with the various stratigraphic methods. In perspective the *spherula stratigraphy* may be developed as an *independent new tool* to study the Solar System bodies on finer temporal resolution.

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